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APPLIED SCIENCES

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ELECTRONIC SOLUTIONS FOR ETHIOPIAN HEALTH SECTOR

Electronic medical record (EMR) system

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Bachelor's thesis
Autumn 2011
Business Information Technology
Oulu University of Applied Sciences

ABSTRACT

Oulu University of Applied Sciences
Degree programme in Business Information Technology
Bachelor's Thesis

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Title of thesis: Electronic solutions for Ethiopian health sector
Subtitle: Electronic medical record (EMR) system
Supervisor: Tapani Alakiuttu
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Number of pages: 48

This thesis gives general information about Ethiopia and addresses the electronic solutions planned and designed by Federal Ministry of Health (FMoH) mainly electronic medical records system (EMRS) in Ethiopia.

As of research methodology I used site observation in government hospitals in Addis Ababa and interview doctors, health officers and high commissioners from federal health bureau. Based on my findings the federal bureau has done and is doing several electronic solutions for health sector.

My main focus on the thesis was on medical record system (EMR) designed by Tulane University Technical Assistance Project Ethiopia (TUTAPE) and called SmartCare. During my research period I noticed some private hospitals in Addis Ababa use their own version of EMR. But the thesis's focal point is on solutions proposed and designed by Federal Ministry of Health. In my opinion once the system designed by the bureau is successful and lighten the burden on the health sector, then it will be the standard system for all private and government based health centers in Ethiopia.

My special thanks and appreciation goes to Mr. Tapani Alakiuttu and Dr. Esko Alasaarela for proposing the idea and to all ICT stuff members of Federal Ministry of Health in Addis Ababa especially Ato Biniam Hailu for giving their time to answer all my questions and provide all the materials that I needed for this paper.

Keywords: ICT in Ethiopia, health care in Ethiopia, patient registry, SmartCare, data warehouse, electronic solutions in developing countries, electronic health record, Ethiopia.

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1 INTRODUCTION

Ethiopia is located in the horn of Africa with a total area of around 1.1 million square kilometres. Ethiopia has federal government structure composed of nine regional states and two city administrations. These regional states and city administrations are further divided in to 801 Woredas (districts) and about 15,000 Kebeles (villages). Population estimates at the national and regional levels are derived from 2007 census by the Central Statistical Authority (CSA). (MoH Health Sector Development Program IV 2010/2011, 1-4)

Regarding the health system, Ethiopia implemented a three-tier health service delivery system characterized by a primary health care unit (PHCU), comprising of five satellite Health Posts, one Health Centre and Primary hospital to serve 5,000, 25,000, and 100,000 people respectively and then general hospital with population coverage 1 million people; and specialized hospital which is expected to serve 5 million people.

Health Posts: One of the satellite facility in the Primary Health Care Unit which serves for 5,000 people (1 per village)

Health centre: It is an establishment which provides both preventive and curative services. It comprises five satellite health posts and is expected to serve for 25,000 people.

Hospital: An establishment that provides general medical care round the clock. It is at least equipped with basic laboratory, X-ray and basic treatment facilities.

District /first level referral Hospital: serves for 250,000 people

Regional Hospital: serves for 1 million people

Specialized Hospital: serves for 5 million people

Presently the need of medical information for clinical decision making become a growing concern, however, in Ethiopia the organization, availability, accessibility and quality of health data are still poor. Moreover, information is not being stored and used effectively in health care resulting in inappropriate and uncertainty in clinical decision-making. In response to this Federal Ministry of Health (FMOH) has put major reform of the Health Management Information System (HMIS) and implementation started in all emerging regions and at federal hospitals and the scale up continued in the remaining regions in order to ensure standardization of procedures in data collection, analysis, reporting and to ensure use of health information for decision making at all levels by providing quality data that help managers and health workers to plan and manage the health service system. (MoH Health Sector Development Program IV 2010/2011, 4-14)

2 OVERVIEW OF ETHIOPIA

2.1 Country background

2.1.1 Geography

Ethiopia lies between 3 and 15 degrees North latitude and 33 and 48 degrees East longitude, it borders with five countries - Eritrea in the north, Djibouti in the east, Sudan in the west, Kenya in the south and Somalia in the south east. The size of the country and its location has accorded it with diverse topography, geographic and climatic zones, and resources.

2.1.2 Population

Based on the Central Statistical Agency (CSA) census (2007) population of Ethiopia is 88million. Ethiopia's population has been growing at a rate of 2.7% p.a. or by an increment of 2 million persons annually. It has become the second most populous country in Africa, following Nigeria. Half of the population (50.1%) is female. The average household size is 4.8. Out of the total population, 85% lives in rural areas, making Ethiopia one of the least urbanized countries in the world. As in many other developing countries, the rate of growth of the urban population (4.1%) is higher than that of the total population growth rate of 2.7%. Rapid population growth exacerbates critical gaps in basic health services. (Ethiopia, Wikipedia)

2.1.3 Administrative structure

The new Ethiopian constitution, introduced in 1994 created a federal government structure. The federal structure is composed of nine Regional States**:** Tigray, Afar, Amhara, Oromia, Somali, Benishangul Gumuz, Southern

Nations Nationalities and Peoples Region (SNNPR), Gambella and Harrari and two city Administrations (Addis Ababa and Dire Dawa).

The National Regional States and City Administrations are further divided into 801 woredas (districts). Woreda is the basic decentralized administrative unit and has an administrative council composed of elected members. The 611 woredas are further divided into roughly 15,000 Kebeles organized under peasant associations in rural areas (10,000 Kebeles) and urban dwellers associations (5,000 Kebeles) in towns.

With the devolution of power to regional governments, public service delivery, including health care, has to a large extent fallen under the jurisdiction of the regions. The approach has been to promote decentralization and meaningful participation of the population in local development activities. For administration of public health care, there is a Regional Health Bureau (RHB) at the Regional level. Due to the Government's commitment to further decentralize decision-making power, woredas are currently the basic units of planning and political administration. (Health and Health Related Indicators 2008/09, 1-3)

2.2 Health sector in Ethiopia

Health care is one of the crucial components of basic social services that have a direct linkage to the growth and development of a country as well as to the welfare of society.

2.2.1 Health sector strategy

Federal ministry of health's health sector strategy is as follows (Woreda Based Annual Core Plan 2010/11, 7)

Mission: To reduce mortality, disability and improve the health status of the Ethiopian people through providing and regulating a comprehensive package of

preventive, curative and rehabilitative health services via a decentralized and democratized health system.

Vision: To see healthy, productive, and prosperous Ethiopia

Core Values of Ministry of Health:

- Community first
  - to serve and satisfy Ethiopian community
  - to treat the people as they want to be treated
- Collaboration
  - together in a spirit of mutual support and understanding to achieve collective goals.
- Commitments
  - no matter what challenges they face and discomforts they feel, they stand firm, be patient and exert their utmost and sustained effort to achieve their goals.
- Change
  - to innovate new ways of doing things and be open mind to reforms.
- Trust
  - to ensure minimum vulnerability and integrity to each other.
- Continued professional development
  - education, professional behavior and ethics, competence and performance in work duties.

2.2.2 Health sector customer value proposition

Table 1. Ethiopian Health Sector Customer Value Proposition (Woreda Based Annual Core Plan 2010/11, 8)

Product or Service Attributes	Image	Relationship
The products and services that the Ethiopian Health Sector provides have the following characteristics: • Accessibility-information, physical, financial, etc • Timeliness of services • Quality of health care services and information • Safety and healthy environment • Empowering community and employees • Conducive environment	The image that Ethiopian Health Sector wants to portray has the following characteristics: • Transparent • Supportive • Trustworthy • Professional • Customer-friendly oriented • Committed	The relationship that Ethiopian Health Sector wants to have with its community could be described as: • Complimentary • Cooperative (participatory) • Respectful and ethical • Harmonious (Mutual Understanding) • Transparent Relationship • Responsive • Equitable

Table 2. Strategic Perspectives (Woreda Based Annual Core Plan 2010/11, 9)

Perspective	Key Concept	Key Question
Community	"Empowerment" "Engagement" "Ownership"	How can they enable the Community to produce and won its health?
Financial	"Effectiveness"	How do they mobilize and utilize more resources effectively and efficiently?
Integration and Responsiveness (Internal Process)	"Quality"	How can they enhance their integration and responsiveness in order to improve quality, timeliness, and functionality?
Capacity Building (Learning and Growth)	"Capacity"	To excel in their processes, what capacities must the health sector and the community has and should improve?

3 ICT PROJECTS PLANNED BY THE FEDERAL MINISTRY OF HEALTH

3.1 Executive summary

The Federal Ministry of Health, supported by its technical partners, is involved in a number of ICT projects and services. These projects and services have been classified into following major areas: (Concept notes and status of ICT programmes implementation 2009, 5)

- Data Warehouse
- Electronic Medical Records (EMR)
- Geographical Information Systems (GIS)
- Health-Net
- IT Operations Support
- Tele-Education
- Telemedicine
- Human Resource Information System (HRIS)
- Website Development
- Health Integrated Financial Information System (HIFIS)
- Electronic Health Information Management Information System (eHMIS)
- Woreda-Based Planning System

3.2 Introduction to ICT solutions

ICT is a key area for improving service delivery, promoting easier information exchange, assisting in decision making processes, and improving the effectiveness of operations. Governments and organizations around the world are mainstreaming ICT as a tool in all sectors of activities. In this regard, organizations need to invest a lot of resources to use ICT as a supportive tool

for the effective and efficient delivery of services. ICT is a cross cutting area which supports all function and operation areas by facilitating the automation of various processes. The Ministry of Health (MOH) has recognized the benefits of Information and Communication Technology (ICT) as a tool to support the health sector.

The following sup topic presents an overview of the major areas of ICT project implementation, encompassing the concepts, the status of implementation and the way forward for each project.

3.2.1 Data warehouse

The idea of Data warehouse
What is data warehousing?

"A data warehouse is the main repository of an organization's historical data, its corporate memory. It contains the raw material for management's decision support system. The critical factor leading to the use of a data warehouse is that a data analyst can perform complex queries and analysis, such as data mining, on the information without slowing down the operational systems." (Data warehouse, Wikipedia)

A data warehouse project is important to ensure that development of a data warehouse is carried out using a well thought out project management approach. This way of doing things is important for any serious undertaking. However, it is particularly important for the warehouse because: (Biniam 18 August 2011, interview)

a) It is a relatively large effort that will take a substantial amount of time to complete,

b) It will involve doing something new and unfamiliar in the environment of Ethiopian healthcare, and

c) Cooperation with a number of external parties is required. Each of these factors makes success more difficult, and addressing them requires substantial commitment from the Ministry of Health.

The key point is that the warehouse contains data that is developed during day to day business (transaction processing), and that the data is organized to make reporting easier.

The actual use of the warehouse is for developing “business intelligence”, that is, for reporting. There are two ways for doing this:

- Through the creation of standard reports
- Through providing tools that enable non-IT users to extract information that will be useful to them.

Each of these is important. In Ethiopia, health bureau are likely to start by providing pre-defined reports, and later to make tools available that allow more extensive querying.

Standard Reports

Depending on the data sources chosen for the warehouse, it seems reasonable to start by using the warehouse for reports that are currently created manually. This would provide an initial benefit, and would provide information that could be distributed to regions and, depending on the initial scope, to *woredas* as well. An important analysis task for the warehouse will be to determine which additional reports would be useful. This of course, depends on the scope of included data.

Ad hoc Queries

There are a number of ways to support queries. This ranges from providing an export file which can be manipulated in a program such as Microsoft Excel, to using tools that directly support user access and that enable a wide variety of statistical analyses. While the ability to carry out a wide variety of queries is a core element of the warehouse, this feature will be the last to be fully explored since all the others need to be in place before it can be delivered.

A comprehensive vision for health information processing in Ethiopia ought to define the kinds of data processing solutions that will ultimately be implemented at all levels, from the national to the health post.

3.2.2 Electronic medical record (EMR)

The Electronic Medical Record is a computerized patient tracking and Patient caring system. In health informatics, an EMR is considered by some to be one of several types of EHRs (electronic health records), but in general usage EMR and EHR are synonymous. The term has sometimes included other systems which keep track of medical information, such as the practice management system which supports the electronic medical record. EHR is an essential technology for health care and a necessary tool for improving patient safety and the quality of care.

Availing quality and timely Health Information at various levels of decision points throughout the country's Health system is very essential for the improvement of Health Care and overall Health System in Ethiopia. The benefits of using an EMR includes, increasing the quality and speed of access to Health Information and the effectiveness of the Health System.

In Ethiopia, the implementation of EMR is through software called ***SmartCare***. ***TUTAPE*** (Tulane University's Technical Assistance Program for Ethiopia) is developing the SmartCare software in partnership with ***Tulane*** University, ***CDC*** and the Federal Ministry of Health Ethiopia (F***MOH***). (Concept notes and status of ICT programmes implementation 2009, 16)

SmartCare was first developed, tested and deployed in Zambia by CDC for HIV/AIDS care and treatment. Besides the rich and advanced functionality and features, SmartCare has also been proven to work in limited resources environment of developing countries particularly in Africa. SmartCare possesses numerous advantages and features in comparison to existing EMR

applications. Ethiopia thus adapted SmartCare as the preferred EMR application. Chapter 4 will discuss more about SmarCare Ethiopia. (Biniam 18 August 2011, interview)

3.2.3 Geographical information systems (GIS)

Today, geographic information systems, remote sensing (RS) satellites and other environmental observing technologies are providing researchers with the tools and the data to make clear the geographic relationships between environmental habitats of disease vectors and agents and the occurrence of disease. Whereas health professionals can effectively analyze the incidence and direct cause of illness, however they may lack the information and expertise to relate the occurrences of diseases with the environment.

GIS and RS have the capability to gather data to assess outbreaks of diseases, pathogens, and environmental contaminants that adversely affect human health and watch and model environmental and habitat changes, such as altered land use patterns and urban growth, which increase the rate of human exposure to other geographic location. To work out with and to use the application of GIS and RS, it needs wide range spatial and timely available data.

The establishment and maintenance of Federal and Regional spatial database system could help in meeting the information needs of various development actors in the country through primary and secondary data collection. It can elevate development efforts by making information accessible to users through effective and efficient information management system. With the establishment of the system at federal and regional level, it will be possible to maximize benefits through collaborative efforts. (Concept notes and status of ICT programmes implementation 2009, 20)

For these reasons Tulane University is assisting the ministry of health all the way through provision of technical and material supports in different dimensions. Among one of the scope is establishing health information center

maintained under geographic information system environment. And basically, the spatial health information system database can serve in provision of timely information on epidemiology, health Facility distribution and status of Services for decision makers, professionals and communities. (Biniam 18 August 2011, interview)

3.2.4 Health-net

HealthNet is envisaged as an ICT Network to support the mission and vision of the Federal Ministry of Health and the Ethiopian Health Sector. The system and network will enable government hospitals, health centers and universities to maximize the existing opportunities and expand facilities for telemedicine, tele-education, video conferencing, voice and data transmission and bring about an improvement in the virtual referral system. (Concept notes and status of ICT programmes implementation 2009, 31)

Many countries all over the world are beginning to apply information and communications technology (ICT) to various aspects of the economy and society including governance, education, health and other areas. This is not strange to the government of Ethiopia, because the government has invested hugely in the establishment of ICT networks to connect schools (SchoolNet), to connect government institutions (Govnet and Woredanet), to connect revenue posts (RevenueNet), to connect Higher Instutions (EtherNet). However, these networks have not been extended to the health institutions.

Health Care is a fundamental service of the government, enabling the government to guarantee equitable provision of health care services, productivity and welfare of the people. Because of the role that the existence of properly functioning network can play in supporting a sector it is anticipated that the creation of a HealthNet will go a long way in improving the health status of the people of Ethiopia.

The key objective of the HealthNet Project is the creation of a virtual network called the HealthNet that interconnects all the various government health institutions, agencies, facilities and individuals of the health sector, that can be used to enhance data flow and information sharing which is beneficial for realization of the goals, objectives, vision and mission of Ministry of Health and of the health sector. It is envisaged that the HealthNet will improve services areas in accurate, quality and timely flow of health information as well as effectively support the existing and future systems such as HMIS, HR, Finance, Expert Systems and others. This will eventually improve the system and services for health care, treatment and prevention. (Biniam 18 August 2011, interview)

3.2.5 IT operations support

ICT implementation is an important aspect of the works of the Federal Ministry of Health. There are various IT related programmes and projects. The IT Operations Support function is the stratum that supports all the other projects. This section presents the IT Operations Support aspect of the ICT programs indicating the structure as well as status and way forward for the implementation.

This division carries “modernize and expand improved health services coverage using ICT” as a vision and” improve service delivery, promote easier access, exchange up-to-date information, assist in decision making processes and improve the effectiveness of operations” as a mission. (Concept notes and status of ICT programmes implementation 2009, 33)

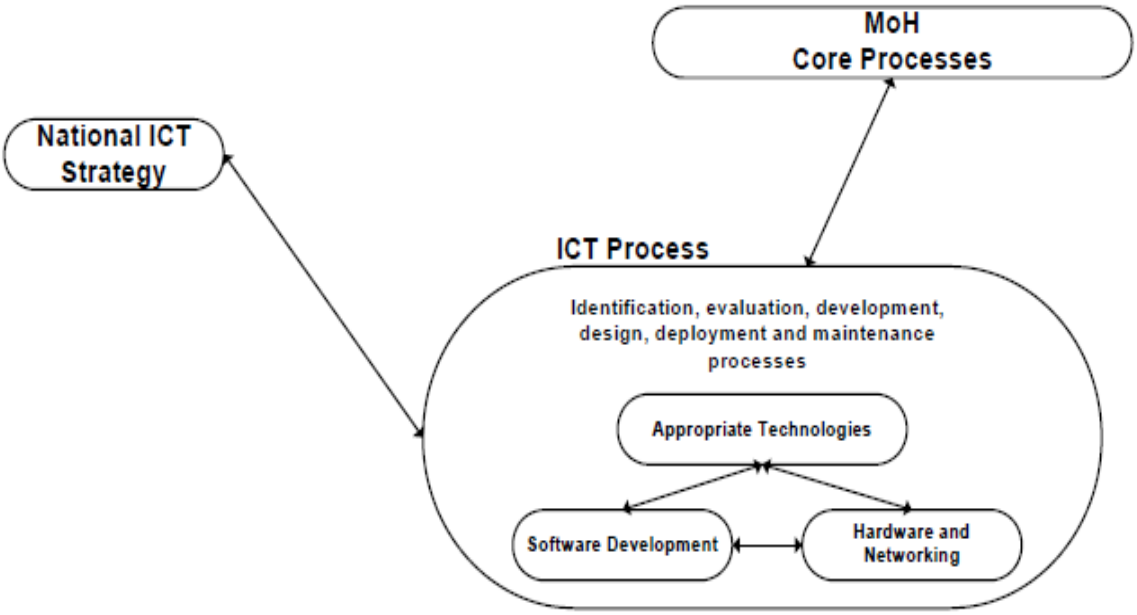

Fig 1. National ICT Strategy (Concept notes and status of ICT programmes implementation 2009, 43)

3.2.6 Tele-education

Ministry of Health has an objective to increase the quality and number of health and medical professionals in the country. To accelerate and enhance the quality of health and medical professionals skill both in-training and in-service through the use of mix of Tele-Education and pedagogical methods including traditional, paper-based, CD and DVD, and e-education system.

eHealth is a concept that covers the broad range applications of information and communications technology (ICT) for health in areas of care, capacity building and training of health professionals. The World Health Organization (WHO) sees eHealth as crucial aspect of the health delivery system of a country. In resolution A58/21, WHO states:

“eHealth should have an impact on health system by making health services more efficient and improving access to care, especially in remote areas for people with disabilities, and for the elderly. It should benefit health-care providers, professionals and final users through higher quality of care health provision. It should also affect the cost of care by reducing redundancy and duplication of examinations and making possible economies of scale.” (Concept notes and status of ICT programmes implementation 2009, 48)

Distance Learning, Distance Education, E-Education, E-learning and Tele-Education are concepts that have been interchangeably used. There are slight theoretical differences between these concepts. The most commonly term in Ethiopia are Distance Learning and E-learning. (Concept notes and status of ICT programmes implementation 2009, 48)

E-learning

E-learning was defined by the American Society for Training and Development (ASTD) as *the delivery of content via the Internet, intranet-extranet, audio and videotape, satellite broadcast, interactive TV, and CD-ROM. However, the marketplace has generally accepted e-learning as applying only to the Internet, possibly because of the nature of email*.

Tele-Education

In Ethiopia “Tele-Education” is commonly used as a synonym for Distance Learning, Distance Education and E-learning, as education intermediated over a distance, however, Tele-Education emphasis the use of telecommunication infrastructure in education. Tele-Education is the use of technology, especially information and communications technology (ICT), to design, deliver, select, administer, support and extend learning. Technology is used as a method of bridging the distance gap, presenting various media types, reinforcing information, in order to facilitate access, to support learning resources and to manage learning with the aim of enhancing the knowledge-base of the individual learner.

Tele-education is associated with various advantages over the traditional face-to-face and paper-based formats. The advantages include: facilitating access, reducing cost, increasing content scope, relevance, empowerment of the students, speed, efficiency and connection.

Tele-Education Delivery Media

A plethora of media technologies exist for facilitating learning over a geographically separated area. Each medium has its own advantages, disadvantages as well as the right situation in which it could be used. Media that have been in Tele-Education initiatives include: (Concept notes and status of ICT programmes implementation 2009, 52)

- Asynchronous Web-Based Instruction (WBI)
- Audio Conferencing
- Audiographics
- Computer Based Instruction (CBI)
- Correspondence (Paper-based or print media)
- Instructional Television (ITV)
- Recorded Audio (Tape and digital broadcast)
- Recorded Video (Tape and digital broadcast)
- Satellite e-learning
- Synchronous Web-Based Instruction (WBI)
- Video Teleconferencing (VTC)

3.2.7 Tele-medicine

Telemedicine is most commonly defined as "the use of communications and information technology to deliver health and health care services and information over large and small distances". Telemedicine can encompass the delivery of a broad range of health services. Telemedicine networks include: health information (clinical information such as patient records, administrative information like service utilization data, research information such as analyses and findings), images (still or moving), signals (vital signs, ECGs), audio (heart

beat, voice) and multimedia (audio, image, text). (Concept notes and status of ICT programmes implementation 2009, 67)

Telemedicine is proposed as a solution to many problems of healthcare delivery to rural as well as urban disadvantaged communities. It could be argued that if an adequate telemedicine infrastructure was established in a country, this would lead to an improvement in the provision of services. Telemedicine main functionality and value is to bridge barriers of distance –it is generally not implicit that another significant contribution of telemedicine is to bridge the barrier of time. Indeed, there is a mistaken general assumption that the encounter provider-client is always held in real-time. In reality, telemedicine creates a whole new range of possibilities by allowing providers and clients to interact using store-and-forward techniques, thus liberating providers and clients from the need and constraint of synchronous encounters. (Biniam 18 August 2011, interview)

Types of Telemedicine

1. Telemedicine: all forms of medicine-at-a-distance;
2. Inter-institutional: the exchange of patient, clinical records and databases;
3. Tele-education: for professional education (e.g. Continuing Medical) and for public education (e.g. self-care)
4. Tele-monitoring and Telecare: for remote home care and emergency networks.

Telemedicine in Ethiopia could address issues related to:

- The escalation of healthcare services cost
- The rapid change in the epidemiology of diseases brought by the rapid transition of population.
- The fact that Ethiopia is plagued with shortage of human resources, particularly in the specialized categories: the doctors, nurses, and pharmacist.

Pilot project for Telemedicine has been started in Jimma University.

3.2.8 Human resource information system (HRIS)

Human Resource Information System is a link between Human Resource activities and processes with the information technology field. The basic focus of HRIS is to provide managers with appropriate knowledge, information and tools to assist them in the management and development of their staff for effective delivery of service. (Concept notes and status of ICT programmes implementation 2009, 76)

Typically, a HRIS includes data for personnel, payroll, benefit system, standardized reporting and ad hoc reporting. Most of the time the reporting is web based and can have different type of beneficiaries (Human Resources Personnel's, Training Institutions, Partners and other agencies that either use or produce HR data). The data and information generated from the HRIS can eventually be used for budget management, people management, learning development, workforce planning and others important purposes.

Prior to the implementation of this HRIS, the Federal Ministry of Health of Ethiopia uses a full-scale paper-based Human Resource Management system incorporating a lot of pitfalls. The common challenge in reaching their goal is on understanding functional/features offered by the existing paper-based systems, as well as to determine how the process can be automated to offer a better system. (Biniam 18 August 2011, interview)

The first version 1.0.0.1 contain the various functionalities including: Admin (for Administrative control), Personal Information Manager (PIM), Reporting, Leave Management, and Recruitment. The versions are versioned to be a system that is envisioned to provide a seamless, consistent, customer-focused, and quality-driven system of services to ensure a competent and vibrant workforce. Tulane University Development team has developed a Human Resources Information system as a tool to help achieve Ministry of Health in its stated vision above.

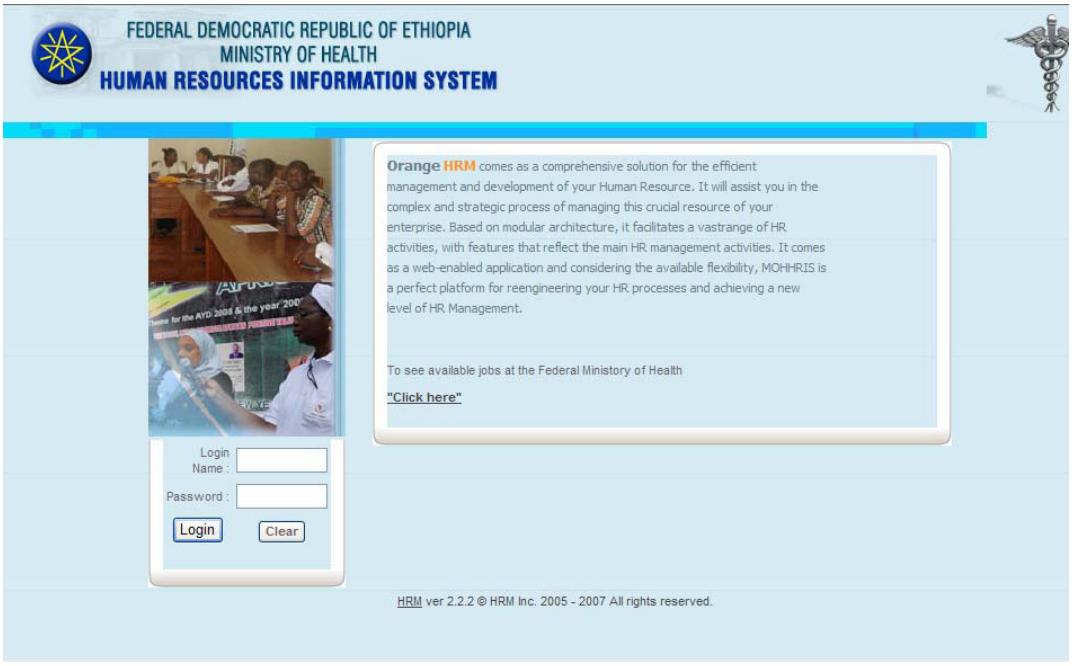

Fig 2. Login Screen

Fig 3. Basic Menu

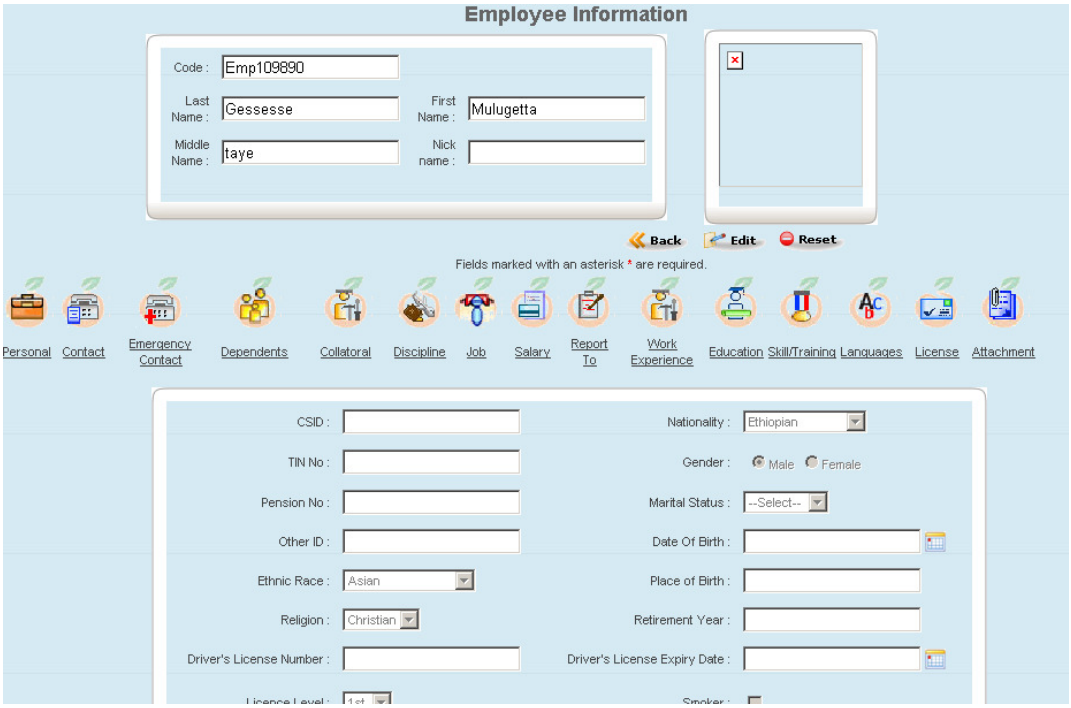

Fig 4. Personal Information Manager (PIM) registration form

3.2.9 Health integrated financial information system (HIFIS)

The Federal Ministry of Health of Ethiopia (FMoH) planned to undertake the implementation of health sector integrated financial management information system to provide the ability to link accounting and financial management activities of the ministry, with the planning and programming activities. That will help to enable the management at all levels of the health system in decision making. (Concept notes and status of ICT programmes implementation 2009, 88)

FMoH has received budget support from the United Nations Population Fund (UNFPA) to undertake activities in design, project management, and implementation of financial management system with an Enterprise Resource Planning (EPR) such as Oracle or SAP. (Biniam 18 August 2011, interview)

The implementation of the HIFIS will be undertaken in three phases :

- Phase I – Design of the System

- Phase II – Implementation of the HIFIS
- Phase III – Maintenance and Support

3.2.10 Woreda-based planning system

WoredaPlanning is a methodology used by MOH to make health related plans for each of the Woreda (districts) every year. The plan includes how many hospitals to be built, how many health posts to be built, how many are needed, how many are available and etc. There is an option for entering needs and gaps so that MOH would be able to plan on how to narrow the gaps. In the past this was done using a paper printout of all the Planning Items and the assigned "Mentors" filling out the paper format. Using the WoredaPlanning software, the Mentors could now enter everything in the computer. (Concept notes and status of ICT programmes implementation 2009, 91)

WoredaPlanning software has two different projects one for the baseline data collection and it is standalone software and the second one a web based application for planning. Both allows users to gather and store information of different programs from a given Woreda and map the collected information with standard baseline of planning template which is a web based program allows the user to enter target and budget of each program such as malaria, HIV/AIDS, etc…it also generates different kinds of reports and aggregation of each region.

WoredaPlanning software is suited for the user with the following benefits:-

- Accessing - retrieving information easily.
- Managing – organizing information easily.
- Updating – editing information easily.
- Merging – putting the information gathered from each Woreda together easily.

The designed system requires little space to store information, designed with backup to avoid data loose, defines users role to enhance the system security level and with its defined input valuator user enters only valid data and users must fill up compulsory fields marked with * sign.

4 SMARTCARE ETHIOPIA

SmartCare software development in Ethiopia happened in collaboration with the SmartCare team in Zambia and the United States. SmartCare is developed using the most cutting age and accepted technology from Microsoft, including .Net framework, .Net Language C#, & Microsoft SQL database. The SmartCare software application was adapted according to the recent Ethiopian HMIS reform conducted by the FMOH. All customizations of the software are conducted by TUTAPE's Ethiopian software developers in collaborations with FMOH, Zambia's SmartCare team and consultants from the US. Even though several thousands miles away, the Team seamlessly communicated using a Microsoft technology called Team Foundation Server (TFS). Using TFS, the different teams were able to share exchange and track the development efforts. (Concept notes and status of ICT programmes implementation 2009, 15-19)

SmartCare gained recognition as the Electronic Health System Application for Ethiopia followed by a presentation and live demo of the customized SmartCare EMR. The presentation was to the FMOH officials including Ministers, State Minister, Department/Agency Heads, Regional Health Bureau Heads, and other relevant stake holders.

To improve the performance of the HMIS, Ethiopia contracted with the consulting firm John Snow, Inc. (JSI) in 2006 to perform an evaluation and redesign of the HMIS. As the HMIS is predominantly paper-based, this project was to culminate in the design and deployment of an electronic HIS, following reform and revision of the existing paper-based system. As of 2008, a comprehensive electronic HMIS has been developed in conjunction with doctors associated with Tulane University and is now being deployed to health facilities in several regions of the country, with an eventual nationwide rollout eventually slated to occur. (Biniam 18 August 2011, interview)

4.1 SmartCare features

SmartCare's most attractive features include the ability of SmartCare to personalize Patient's medical record by using SmartCards. SmartCards are pocket/credit card sized plastic cards embedded with an electronic memory chip capable of storing Patient's information. Furthermore, SmartCards are used as an ID for a patient so that it will easier to filter and retrieve his/her record and history during the follow-up sessions or visiting different point of services like reception, laboratory, pharmacy and so on. (Biniam 18 August 2011, interview)

SmartCare has the ability to function in either as a distributed (standalone) or as a centralized (client/server) mode. The distributed mode is used in the absence of online communication infrastructure were SmartCards are used to transport Patient data between different points of services. Further in this mode, SmartCare provides database merges by using any electronic data storage and exchange (e.g. flash disks, CDs) methods across all points of service.

In the centralized mode, SmartCare hosts the database on a central server and using online communications infrastructures (LAN/WLAN, WAN), enables all points of services to obtain real time access to Patient's information. (Biniam 18 August 2011, interview)

SmartCare is developed using an Industrial standard modular architecture. This provides the added advantage for simultaneous and phased development of various components of the application, without affecting the stability and integrity of the application. Other features of SmartCare include Role Based Security, Data merging, import/export, backup/restore and Touch Screen technology for easy and very user friendly interface.

4.2 SmartCare deployment in Ethiopia

The deployment of SmartCare includes building/strengthening ICT infrastructure (Hardware, Software, & Networking components) and the Installation and Training of SmartCare software application at the Health Facilities. SmartCare is installed and introduced in phases. The initial installation/introduction phase starts at the Medical Record Room were the bulk of data encoding takes place followed by other Clinics including Out Patient and In Patient, Laboratory, Pharmacy. (Biniam 09 November 2011, e-mail messaging)

SmartCare is used by Clinicians, the Health Facility Heads, Data Entry Clerks, & the HMIS officers. Patient information is encoded in SmartCare by either Clinicians or Data Entry Clerks depending on their allowed role security which defines the module, they get access to. Data could be encoded and/or viewed either while the Patient is within the health facility or after the patent has left.

4.3 SmartCare's current status in Ethiopia

More recently, Ethiopia has seen a significant deployment of the SmartCare system used in Zambia. Over 100 clinics and hospitals in the Dire Dawa region, covering the entire area, have successfully deployed this system for building and maintaining electronic medical records, which will improve both the quality of health information as well as patient care. (Biniam 06 November 2011, interview)

Ethiopia has 11 regions. Dire Dawa administrative region was identified to be the most favorable since it was possible to create a controlled environment for the initial phase of the deployment. Thus Dire Dawa nominated for the initial phase and chosen as a pilot site. During the initial phase, interactions will be recorded for future improvement of the system. Prior assessment to identify and map ICT resources was performed. WLAN design and deployment was performed at six health centers and one hospital. Lately they are starting the

deployment of SmartCare in St Paul Hospital in Addis Ababa. Biniam 06 November 2011, interview)

4.4 Why SmartCare?

The reason why Ministry of Health decided SmartCare to be an official Patient Registration System in Ethiopia is because of the following benefits: (Biniam 06 November 2011, interview), (Biniam 09 November 2011, e-mail messaging)

Simultaneous, remote access to patient data

Multiple clinicians can access a patient's record simultaneously from many locations. With the recent advent of secure data transmission over the web, clinicians can now review and edit patient records from anywhere in the world.

Legibility of record

Handwritten charts are notoriously difficult to read. On-screen or printed text is often far more legible than handwriting.

Safer data

New users often fret over the potential for lost data due to system malfunctions. With a well designed and tested backup scheme and disaster recovery system, a computer-based record is much more reliable and less prone to data loss than conventional paper-based records.

Patient data confidentiality

Record access can be restricted and monitored automatically; each user can have specific levels of access to various data types. Audit logs can be screened electronically to look for statistical abnormalities which may signal unauthorized record accesses.

Flexible data layout

Users can have a separate data display and data entry screen, recall data in any order (e.g., chronologically or in reverse chronological order), and create

disease or condition specific data review formats. Paper records suffer from temporal constraints in the sense that data are fixed in the exact sequence in which they were recorded.

Integration with other information resources

Once in electronic form a patient's data can be linked to reference information stored and maintained locally or, via the internet, on a computer half-way around the world.

Incorporation of electronic data

Physiologic data can be captured automatically from bedside monitors, laboratory analyzers, and imaging devices located throughout the healthcare enterprise. Such data capture is free from the uncertainties and unreliability of human data entry efforts.

Continuous data processing

Provided that data are structured and coded in an unambiguous fashion, programs can continuously check and filter the data for errors, summarize and interpret data, and issue alerts and/or reminders to clinicians following the detection of potentially life-threatening events.

Assisted search

In a small fraction of the time required using a manual system, computers can search free-text (or as Octo Barnett terms it "expensive text") as well as structured data to find a specific data value or to determine whether a particular item has ever been recorded. However, unstructured text must be searched with care since clinicians use many different words and phrases to express the same clinical concept.

Greater range of data output modalities

Data can be presented to users via computer-generated voice, two-way pagers, or email, for example. In addition, instructions can be sent to external, computer-controlled devices like automatic pill dispensers, or infusion pumps

which will then carry out the clinician's intended action. Patient-specific alarms can flash lights, ring bells, or buzz buzzers. Finally, multiple single plane images can be transformed back into a

Tailored paper output

Data can be printed using a variety of fonts, colors, and sizes to help focus the clinician's attention on the most important data. In addition, images can be combined with textual data to create a more complete "picture" of the patient's condition.

Always up to date

If the electronic record is integrated, then all data is immediately available to all practitioners regardless of their physical location as soon as the data is entered into the computer. This eliminates the problems associated with several physicians, each keeping a small portion of a patient's Health Record in their offices and transferring these paper-based records back and forth as they consult.

4.5 SmartCare components

SmartCare system is made up of three main components:

1. Individual Patient Data Entry (Clinical Interactions)
2. Data Aggregation (Analysis, Reporting & Use)
3. System Administration (integrity, security, confidentiality)

These components are designed to achieve the following targeted functionalities. : (Biniam 06 November 2011, interview), (Biniam 09 November 2011, e-mail messaging)

Service Integration

SmartCare is designed to automatically and securely exchange data between different services in a facility. It allows communication among different clinical

services, lab, pharmacy, and other networked units and offices. Whether installed in a small clinic or a hospital, it offers different options for data access and synchronizes data, eliminates redundancy of data entry. This integration includes patient demographics, provider notes, investigations, prescriptions and scheduling.

Assisted Searching

SmartCare has the feature to assist the user to use filtering criteria when searching a particular patient from the existing database. If the patient doesn't exist, the new name entered will be taken as a new client and SmartCare, will give you the option to register it or not. If there are similar names entered in to the database, which is most probably the case in most databases, a SmartCare window will pop with the list of similar names in the database; hence, the user can select the appropriate profile to continue.

Simultaneous & Remote Data Access

Authorized providers can access electronic patient charts from a networked computer in another place, no matter where. Using synchronization techniques patient charts can be "checked out" after patient records are created or updated remotely. These records are easily checked back into the database and all patient data is updated.

Record Summaries

Almost all modules have a specific clinical visit summary presented in a spreadsheet. But common to all modules, there are two important summaries for each individual patient visit, the Visit and Dashboard Summaries.

Integrated Smart Card Function

With portable Smart Cards, comprehensive electronic histories of patients will be easily carried and shared among providers in different facilities. This facilitates seamless exchange of patient data. By strengthening these connections within the continuum of care, it puts you one step closer to

accessing all of the data you need when you need it, thereby improving patient care.

Incorporated Dictionaries

Pre-built clinical templates and work flows are developed specifically for clinically significant activities. SmartCare has such features with pull-down menus and point-and-click options to make documenting and decision making fast, efficient and automated. These templates in SmartCare come pre-loaded with very detailed options for documenting diagnosis, procedures, histories, assessments, and more.

Referral Management

SmartCare application allows you to populate outbound referral forms automatically with background data about a patient's condition; treatment authorization data; referral dates; and information about the referring and/or referred-to provider. The software allows you to track whether or not the patient complied with the referral instructions and alerts you when inbound referral reports arrive. Inbound forms can be scanned or transferred electronically into the patient record.

Data Mapping /GIS

Map types include Woreda, health facility point, health facility catchments, and population. Patient data stored at individual level allows for mapping across indicators (e.g. map # patients who receive both HIV and Tuberculosis care). Ability to map indicators by place of residence of patients or the facility they visited.

Query individual level data by province, district, health facility, age, gender, facility type, and/or dates. Choose shading, classification, labeling, zoom level, and background layers schemes and capacity to link with PDA/GPS data

Processing & Outputs

Patient data collected through SmartCare is stored in a relational database as discrete data elements which enable to generate both electronic and printed reports right from the software. The pre-built templates put the reports at the finger tips with tailored information to specifically address the report need in accordance with the HMIS reform and other business needs. Reports can even be imported or exported. Some of the reports include:

- Hospital/ Health Center HMIS periodical Reports
- Patient Demographics
- Individual Service Registers

Clinical Decision Support

SmartCare posses clinical reference dictionaries and interpretations that provide guidance to help providers make more informed decisions at the point of care. Disease diagnosis could be based on limited reportable variables or ICD formats. In SmartCare, will be able to handle unstructured text (i.e., terminology commonly used by physicians in handwritten case notes) and with one click of the mouse, the physician can also be given a differential diagnosis and an instant link to additional information (such as diagnosis-specific investigations, treatments, journal abstracts relating lessons learned from others' errors, and recent advances).

Computations & Graphing

Graphing capabilities give you the data you need in the format that communicates results most effectively. Line graphs and trends allow you to analyze data over time from a variety of perspectives (as in figure below for Child Growth Monitoring). With this data at your fingertips presented in ways that highlight important information, you can evaluate many variables that affect the quality of care.

Data Merge & Aggregation

Individual data collected through SmartCare in a facility could be reported to the next level in electronic or printed form. But data could also be aggregated using the data transporting mechanism of SmartCare from all the facilities and reports could be generated. For instance, a Woreda Health Office would be able to generate a quarterly report by merging data from all its facilities using the same type of SmartCare software installed in the facility. The same process could be applied upwards, in each level.

Administration

The administration component is the last significant grouping of functionality in the SmartCare system. The administration section is used for configuring the application for a particular Region, Woreda or Facility. This functionality helps in administrative operations which should be shielded from the average end user for routine daily task.

4.6 SmartCare Ethiopia screenshot

The following screenshots are taken for the system that's customized for Ras Desta Hospital in Addis Ababa, Ethiopia.

Fig 5. Login Screen. This is the main page for users login. Inputs can be entered with touch screen, mouse and keyboard.

Fig 6. Modules. The main screen with menus that helps to navigate through the entire system.

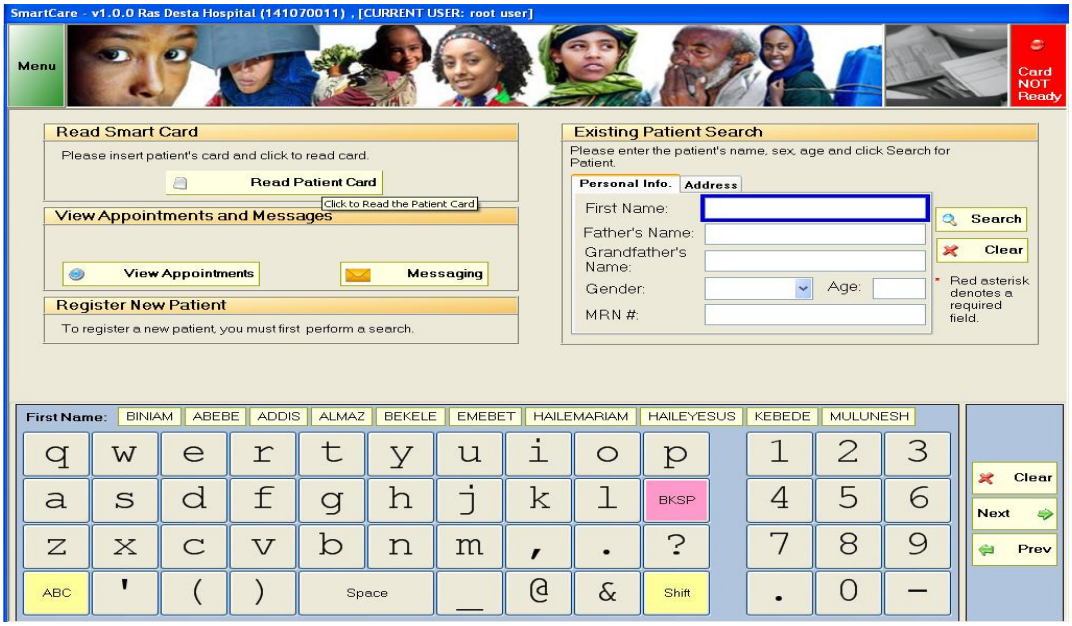

Fig 7. Search/Register Patient form. This window helps to search existing patient either with their smartcard or using name as a search term. The other tab is designed to register a new patient.

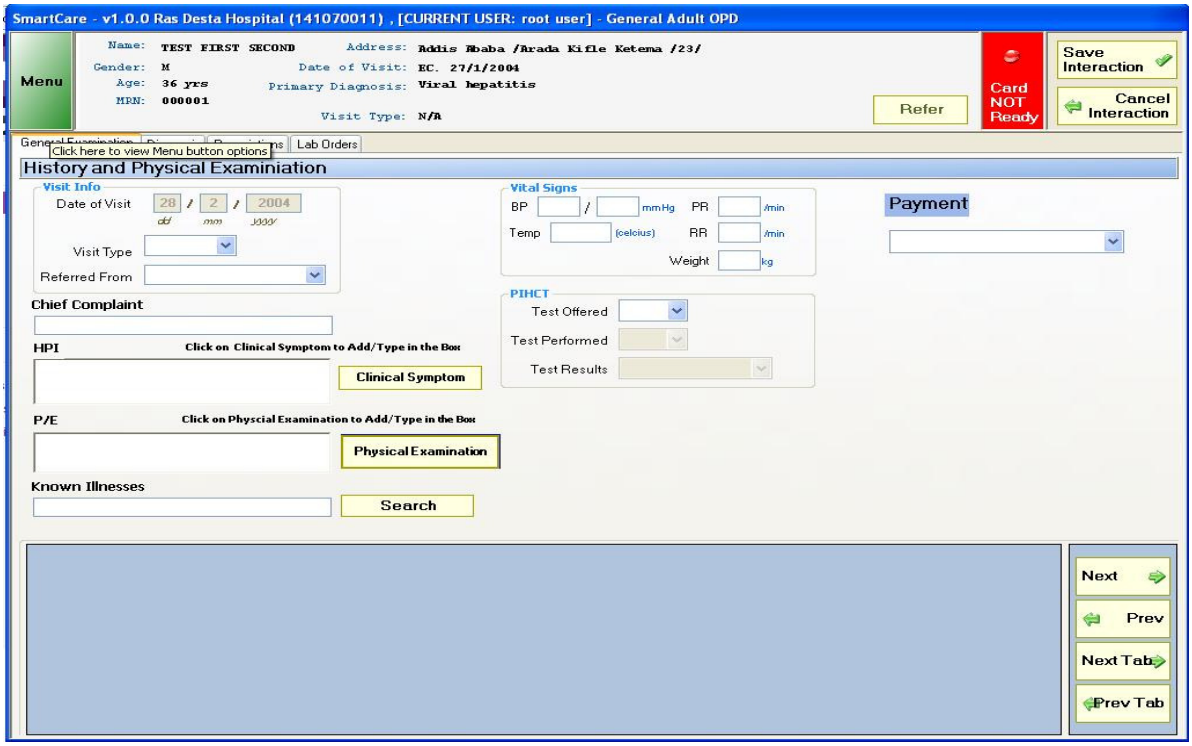

Fig 8. Diagnosis. This window is for viewing patient's history, physical examination, visit information, and clinical symptoms.

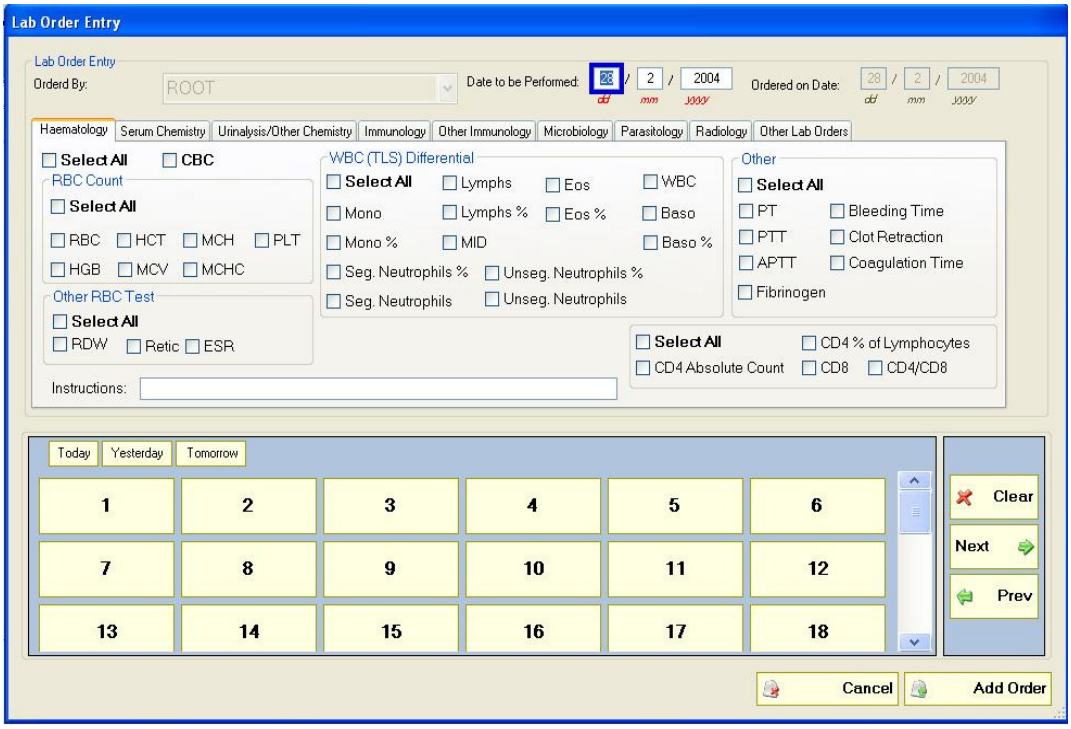

Fig 9. Laboratory Order Entry Form. This module is used by doctors to order for laboratory. This is one logical bridge between doctor and laboratory technician.

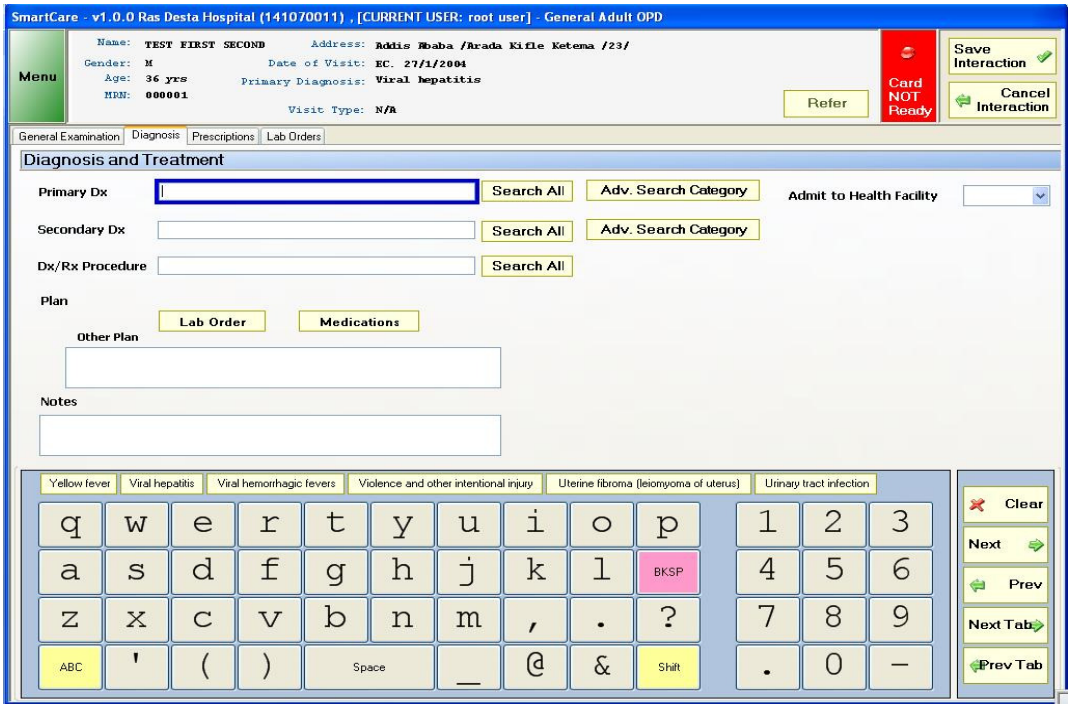

Fig 10. PDX Form. Diagnosis and Treatment form

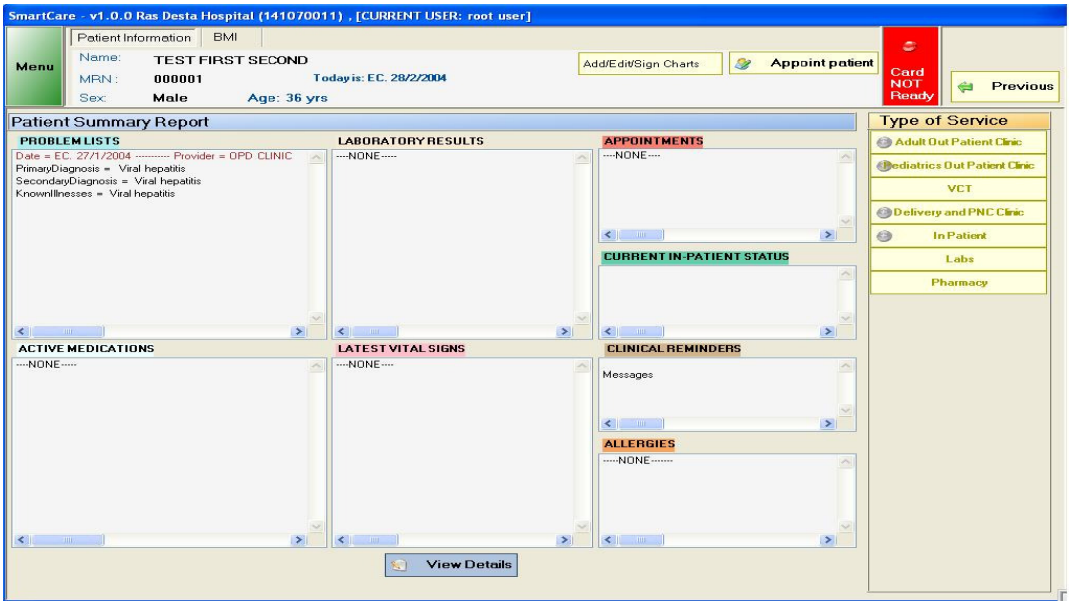

Fig 11. Patient Summary Form. This window gives general summary about patient like laboratory results, upcoming appointments, latest vital signs, allergies, and so on.

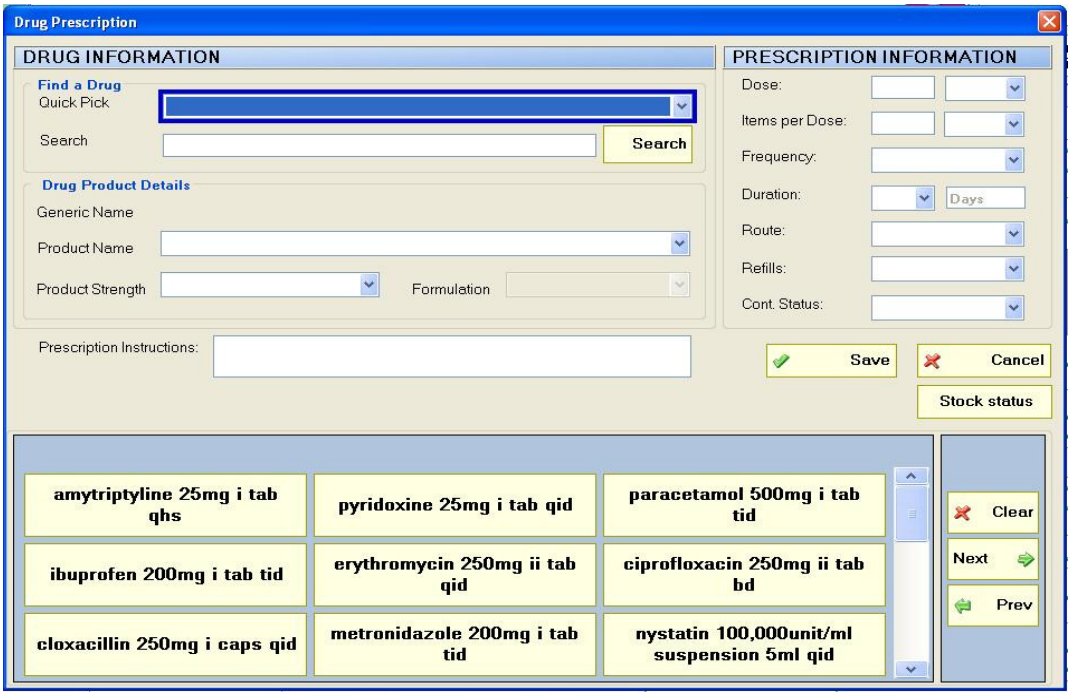

Fig 12. Prescription Form. This helps for doctors to order medicine for their patients. They can find list of drugs from the dropdown menu, they can decide the prescription information like dose, duration, frequency and so on.

5 DISCUSSION

The idea of this thesis started with the conversation I had with my advisors and I start to wonder what kind of patient registry Finnish hospitals has. And I got a chance to visit Oulu university hospital's patient registry system called ESKO. That's the time I got internally motivated to make a difference on Ethiopian patient registry.

So me and my advisors go through the idea. Based on my previous knowledge and experiences on facts about Ethiopian health sector's patient registry system, I started this thesis with the assumption of Ethiopia is still using paper based registration system. My target was to point out problems of the paper based system and propose an automated patient registration system for Ethiopia. To do research and see the problems in person I flew to Addis Ababa, and started to interview doctors and high health officers. It turns to be that the Ethiopian ministry of health has started a pilot project called SmartCare before two years. That really takes me by surprise and makes me dig more and more. The fact that the ministry of health already launched this electronic solutions changed dimension of my thesis. This changed my preliminary table of content and title of thesis.

SmartCare can be counted as one of fully integrated electronic health record system. The system is designed with the feature of distributed database system, smartcard, touchscreen and GIS data visualization. These features enhance the usability of the system like, clinics from rural areas can send their data through LAN/WAN network to central server, with small bank's credit card size patients information can be stored in secured format on smart card so that it will be much easier to save individual's information and retrieve the data in between visits, post ups, health services and health facilities.

SmarCare is capable of working well with touch screen monitor that enables to interact with the database and retrieve patient's information from database. But writing to database from touch screen monitor is not working. The data visualization feature enables to visualize data stored in health posts on GIS maps.

Even if the system has features, benefits and advantages that are mentioned on the previous topics, I noticed few limitations, one of the main thing the system has insufficient documentation. Since the software is closed application and it's owned by ***TUTAPE*** (Tulane University's Technical Assistance Program for Ethiopia), ministry of health doesn't have direct access to make modifications, add modules or improve the system.

The entire system's modifications is taken care by TUTAPE's designers team, even if keeping the system up-to-date is one good thing, in the current trend they are taking user of the system like doctor's opinion and include their wishes in the upcoming versions this makes the system to have multiple versions in short period of time. In my opinion this has few problems on users of the system. Since the ministry of health is promoting this software phase by phase the users get new version before knowing or get adapted to the old ones. This increases the maintenance cost and degrade consistency of system.

One other problem is, that TUTAPE and MoH inherits Zambian experience and change few things to Ethiopic context and then deploy the system. Again in my opinion the system's analysis is not matured enough to suggest solution. Because it's been on pilot phase for the past two years, and every time when a doctor, or health officer propose additional module the request is sent to Tulane University's technical assistance team and they came up next modified version.

From my point of view to solve the problems it's recommended to do well defined analysis based on the country's current infrastructure and existing problem. Then localize SmarCare based on the size of health center, because the system for referral hospital is way much complicated and bigger than system designed for clinic. Besides that there isn't any available documentation,

user manual or technical description about system. Finding information about SmarCare was one of the most challenging part of my thesis.

Even if Tulane University trained couple of Ethiopian programmers and give them the right to maintain the system, it might reduce the maintenance cost a bit but it won't make big difference on solving the problems I mentioned. So I recommend starting such big changes with open source packages, so that the ministry office will have the right to own the system.

Finally I appreciated the Ministry of Health's way of changing things and promoting ICT solutions on health sector it's an eye opening chance for today's Ethiopian ICT era. This will play one big role in building bright one Ethiopia.

GLOSSARY

Admission: Formal acceptance, by a health facility, of a patient who is to receive medical or paramedical care while occupying a health facility bed. Healthy babies born in hospital should not be counted if they do not require special care.

Higher clinic: Staffed at least by a general medical practitioner, a specialist and assisted by various specialists serve for general outpatient clinics. For emergency and delivery this clinics has up to 5 beds.

In-patient: A person admitted to a health care facility and who usually occupies a bed in that health care facility.

Kebele: The woredas are composed of a number of kebele, the smallest unit of local government. Kebeles can best be regarded as a neighborhood, a localized and delimited group of people or ward.

Out-patient: A person, who goes to a health care facility for consultation, is not admitted to the facility and does not occupy a hospital bed for any length of time.

Population: All the inhabitants of a given country or area considered together. Estimates are based on a recent census, official national data or United Nations projections. Presented in thousands or actual value.

Rural: Those working rural areas or in areas outside cities and metropolitan areas generally regarded as underdeveloped in terms of infrastructure and specialized services.

Woreda: A woreda is equivalent to district, managed by local government.

ACRONYMS

ASTD:	American Society for Training and Development
CBI:	Computer Based Instruction
CSA:	Central Statistics Authority
EHMIS:	Electronic Health Management Information System
EMR:	Electronic Medical Records
FMOH:	Federal Ministry of Health
EPR:	Enterprise Resource Planning
GIS:	Geographical Information System
HIS:	Health Information System
HIFIS:	Health Integrated Financial Information System
HMIS:	Health Information Management System
HR:	Human Resource
HRIS:	Human Resource Information System
ICT:	Information Communication and Technology
ITV:	Instructional Television
LAN:	Local Area Network
MOH:	Ministry of Health
PHCU:	Primary Health Care Unit
PI M:	Personal Information Manager
RHB:	Regional Health Bureau
RS:	Remote Sensing
SNNPR:	Southern Nations Nationalities and Peoples Region
TUTAPE:	Tulane University's Technical Assistance Program for Ethiopia
UNFPA:	United Nations Population Fund
VTC:	Video Teleconferencing
WAN:	Wide Area Network
WBI:	Web-Based Instruction
WHO:	The World Health Organization
WLAN:	Wireless Local Area Network

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